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The Cane Growers' Quarterly Bulletin

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Sugar in the Australian Economy*

By NORMAN J. KING

The concentration of sugar production in the north-eastern section of Australia is perhaps one of the reasons why the majority of the population is not better informed regarding it. Its geographical remoteness makes sugar just as alien to Victoria and West Australia as are spice growing in the East Indies or the fur industry of Canada. As a refined, crystalline product sugar is familiar to every Australian and is a universal food, whether taken in beverages, used in cooking, or utilised in jams, confectionery or a variety of other products. Queensland grows and manufactures 95 per cent. of the total Australian sugar production, which, in good years, approaches the million ton mark. Slightly more than half of this amount is used in Australia, the remainder being sold to Britain under agreement. Some idea of the magnitude of the industry is obtained from the cash value of the raw sugar produced which, in 1950, approximated £25,000,000.

It is frequently and erroneously thought by persons not associated with the sugar industry that all profits go into the pockets of large factory magnates and so-called "sugar barons". Nothing could be further from the truth. The agricultural side of the industry is carried on by some 7,000 canegrowers whose average harvested area is only 40 acres. Of the 31 sugar factories which treat the cane and manufacture the raw sugar approximately half are co-operatives and any profits are thus distributed among the growers supplying the crop. In these times of steeply rising costs for both grower and manufacturer the net returns of the sugar producers are well below those of many other primary industries and give no support to the widely held belief of undue prosperity.

The income of the sugar industry is not all retained in Queensland. All sugar consumed in Australia is refined at large plants situated in the capital cities of the various States. Each State therefore benefits by the employment of refinery labour, by the necessary interstate shipping and by the marketing and distribution of the refined product. The wholesalers receive a proportion of the total sugar monies as do also the retailers in every store.

The value of the farms and mills associated with sugar production is in excess of £60,000,000. Some 80,000 persons are directly or indirectly employed in the industry, and since, on

* From an A.B.C. Broadcast Address.

the average, one wage earner supports 2½ other persons, a total of 300,000 Australians are dependent upon sugar for their livelihood. The mills possess 2,000 miles of light railway, 200 locomotives and 31,000 cane trucks to convey the crop to the factories.

But a recital of figures in a talk such as this tends to become overwhelming. Sufficient has been said to suggest the size and ramifications of Queensland's largest agricultural undertaking. The industry is not concerned with increasing the consumption of sugar in Australia; this, on a per capita basis, is already the highest in the world and it is known that when a certain peak of consumption is reached in an economy such as Australia's, the usage tends to fluctuate only with periods of prosperity and depression.

The producers of sugar are interested in providing Australia's total requirements as well as fulfilling commitments with the United Kingdom Government. The agreement which exists between the Queensland and Commonwealth legislatures requires that only the surplus over and above local requirements may be exported irrespective of whether overseas prices are more attractive or not. This has been a very valuable clause to the Australian user. Since 1923 when Queensland first produced Australia's total sugar requirements, world prices have fluctuated between £7 and £30 per ton. In the same period governmental control has maintained local prices at between £21 and £27 per ton of raw sugar. In the nineteen thirties when world prices were lower than local ones an agitation in certain quarters desired the lifting of import restrictions with a view to lowering prices to the Australian consumer. What was overlooked was that the overseas quotations were on raw sugar and would have had to carry such added costs as transport, refining, distribution, and wholesalers and retailers margins. The impact of such an action, if carried out, would have been the replacing of an Australian white labour industry by imported black grown sugar and the decadence of an agricultural economy which is spread over 1,000 miles of vulnerable coastline. On the whole the relatively stable Australian price has not treated the local consumer badly, and it has in addition, contributed largely to the settlement of an important unit in the Commonwealth.

At the present time the Federal Government is being asked to agree to a price rise in sugar—a rise based on steeply mounting costs of production. Even if granted, the price per lb. of the refined product in this country will still be very low compared with either overseas prices or with the trend of Australian wages. The Federal Government has expressed alarm at the falling off of food production in the Commonwealth and its inevitable effect on our overseas trade balance. So long as the sugar producers are able to fulfil all local requirements, every ton exported materially assists our financial economy.

The sugar industry has undoubtedly been the most potent factor in developing such cities as Cairns, Innisfail, Mackay and Bundaberg. This is just as true as giving the credit for Newcastle's growth to coal or Kalgoorlie's to gold. Without sugar these towns would be minor settlements, supporting small populations. The rapidly growing winter tourist traffic has done much to impress visitors from other States with the national importance of the industry, and wartime experience must have caused thinking people to ponder on what the outcome might have been had tropical Queensland been less developed. This section of Australia became the bastion for the continent's defence and much that was accomplished was rendered possible only with the machinery and manpower of the sugar industry.

Australia is a vast country in terms of acres or square miles and a bare statement of acreage under crop conveys little meaning except to the

practised farmer or agriculturist. Perhaps a clearer picture of the land annually harvested for sugar production may be obtained if it is described as equal to the total area under orchard crops in Australia, fifty per cent. higher than Australia's maize acreage or more than twice as great as the area devoted to potatoes. The planting, growing and harvesting are heavy occupations and the lastmentioned in particular demands labour of a high physical standard. Crops average 25 tons per acre, but frequently reach fifty or sixty tons and the man-handling of such amounts in a tropical climate is arduous in the extreme. Mechanical cutting and loading of such a weighty material raises problems not encountered in the relatively light crops obtained from wheat and maize, but these are being gradually overcome and already many types of harvesters and loaders are available. Time will witness improvements to the stage where much of the back-breaking work associated with this industry will be eliminated.

Statisticians and economists have recently been inclined to forecast that the combination of increasing population and industrialisation of this country will result in a shortage of foods within a relatively short period. Only a confirmed pessimist could apply these arguments to sugar. There is still land for reasonable expansion and there is no indication of decreasing production. At the present time the factory owners are spending very large sums on bigger machinery to provide for expansion of production and this can be interpreted as the realization of a responsibility to produce an essential food for Australia and for Britain. The obligation is on the industry to fulfil the requirements of the consumers, and this obligation it has faithfully met for the past twenty-nine years. There have, in very recent times, been shortages of refined sugar in some southern States, but these have not been due to any shortcomings on the part of the producer or raw sugar manufacturer. Ample raw sugar supplies have been available and the refinery capacity has been adequate. The refiners can hardly be blamed for coal and labour shortages, which have resulted in deficiencies of white sugar crystals.

Recent investigations designed to handle raw sugar in bulk from factory to refiner whether in Australian cities or in England—illustrate the determination of industry leaders to keep abreast of modern methods. The raw sugar producers must carry the losses incurred in the storage of a product which is subject to deterioration under wet tropical conditions. Storage time could be reduced appreciably by handling in bulk instead of bags, since it would allow of the more rapid loading and turn round of ships. In addition, the industry would be saved the annual expenditure of a very large sum on raw sugar sacks which have to be imported from jute growing countries. The reduction of sack usage would be in line with the modern trend of national self sufficiency wherever practicable. During the past six months a trial shipment of sugar in bulk, amounting to 9,000 tons, was made to England. Early reports indicate that its condition on arrival was good and this augurs well for future handling in this manner.

It must not be inferred that because this form of tropical agriculture is mainly located in the northern outposts of the continent that its technical efficiency is thereby low by southern standards. The sugar industry was the first agricultural undertaking in Australia to possess its own research organisation and for over 50 years it has supported an ever increasing number of research workers who have raised efficiency to a very high level. When, two years ago, the International Sugar Technologists Congress was held in Queensland, overseas authorities from twelve countries praised the local achievements in variety breeding, pest, and disease

control, plant nutrition and manufacturing efficiency. The centres of the sugar industry may be, in terms of miles, a long way from Melbourne and Sydney, but they are certainly not lagging behind other avenues of primary production in virility, accomplishment and proficiency.

Sugar producers pioneered settlement in tropical Australia and are indirectly responsible for the harbours, roads and railways along Queensland's coastline. These developments paved the way for other industries, both primary and secondary, which on their own would not have justified big harbour installations or railway extensions. The existence of modern transport facilities makes attractive the proposition to use coastal North Queensland for large scale cattle fattening as well as for the growing of a range of tropical crops which are at present imported. The sugar industry has therefore contributed more to Australia's economy than the production of sugar, valuable though that achievement is. In the same way that the eighteenth century gold rushes attracted populations which entered fields of endeavour other than gold seeking, so the pioneers of sugar production opened country the value of which was ultimately recognised for other purposes. To the casual winter tourist, North Queensland brings a breath of the south seas with its tropical palms, mountain scenery, lush vegetation and balmy climate. To those who peer a little below the surface it is a thriving and busy community with the sugar industry providing the life blood; a high pressure, manufacturing undertaking in which the factories work 24 hours a day for six months of the year; and an agricultural bee-hive which grows, harvests and delivers sugar cane by the millions of tons to the ever-hungry mills.

Inspectors and Honorary Inspectors under "The Sugar Experiment Stations Acts, 1900-1951"

His Excellency the Governor, with the advice of the Executive Council, in pursuance of the provisions of "The Sugar Experiment Stations Acts, 1900 to 1951," has approved that all existing appointments of Inspectors and Honorary Inspectors be cancelled, and that the following be appointed Inspectors and Honorary Inspectors under and for the purposes of the abovementioned Acts:—

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G. Bates	K. C. Leverington
A. F. Bell	R. W. Mungomery
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I. H. Buzacott	J. H. Nicklin
G. A. Christie	E. A. Pembroke
A. G. Claire	C. Rehbein
J. L. Clayton	S. O. W. Skinner
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H. W. Koppen	V. Wood
P. J. Long	I. A. Wood
E. J. R. Luckett	I. M. Wright
R. B. Moller	F. V. Youngman

Notification of the above appointments was published in the Government Gazette of 8th March, 1952.

Sclerospora Disease

By D. R. L. STEINDL and N. McD. SMITH

The recent outbreak of Sclerospora disease in the Moreton mill area has attracted attention to this hitherto unimportant disease in sugar cane. It was first recorded in a seedling cane from northern New South Wales in 1940, and was thought to be dwarf disease until a microscopic examination of the leaves was made. In 1941, it was found in POJ2878 at Bundaberg, and since then odd diseased stools have been found in various districts from Mossman to Rocky Point. Early this year a specimen was received from Peru for identification. It was considered there that it could be dwarf disease, but confirmation was required since dwarf disease does not occur outside Australia. However, examination here revealed that it was Sclerospora disease, and this is the only record we have of the disease occurring outside Australia.

The first record of Sclerospora disease in the Moreton district was in 1947 when isolated stools were found in CP29-116 and POJ2878 on Petrie Creek. The disease has occurred sporadically since then, but was not considered of any importance compared with Fiji, chlorotic streak and mosaic diseases. However, during the current year, it became apparent that considerable spread had taken place along Petrie Creek adjacent to the original outbreak, and regular roguings were initiated. Some fairly heavily infected blocks were found in this area, while isolated blocks at Maroochy River and Paynters Creek were found with very light infection.

To date a total of 143 diseased stools have been rogued from the following varieties: CP29-116, Pindar, Q28, Q42, Q47, Q50, and Trojan. In addition, 52 diseased stools were found in a block of Q42 at the Island Plantation, Maryborough.

In all cases where the disease has been found, the crop has been subjected to inundation by flood waters. One particular case worth mentioning was a one acre field of Trojan 1st ratoons which consisted of two terraces. The lower terrace on the edge of Petrie Creek consisted of approximately 2,000 square feet. Forty diseased stools were found in that area while the higher terrace, which was only twenty feet above the diseased area, was quite free from the disease. This fact supports the view that the spores of the causal fungus are dependent on water for dissemination, and the widespread infections this year are probably the result of the protracted wet period of 1950-1951. All the disease found at Moreton this year has been in ratoon cane, and it is obvious that the cane was not diseased when planted, since the disease did not occur in "stick lots" as would have been the case had diseased material gone through cutter planters which were used in most instances.

Symptoms vary somewhat with varieties, but in general they consist in a severe stunting of the stool and profuse tillering which condition somewhat resembles dwarf disease, and to a lesser extent, cluster stool. The leaves assume a yellowish green colour, which on close examination is found to be due to irregular yellowish streaks between the veins. These streaks are from $\frac{1}{4}$ inch to several inches in length and have fairly straight sides although they are not sharply defined. The ends are frequently broken irregularly and irregular normal green areas occur within the streaks. Frequently the whole leaf is affected, while in some cases only certain sections show these markings. As with mosaic disease some varieties show the markings with much more clarity than others.

Fig. 1—Resting spores of the sclerospora fungus highly magnified.

The edges of the leaf become wavy, giving it the appearance of a corn leaf, and the top usually droops. Later the leaf margins wither and small sections break off giving the plant a ragged appearance. If a diseased leaf is examined with a lens magnifying 10x or upwards numerous minute white specks can usually be seen alongside the veins; these are the fungus spores embedded in the leaf tissues, and are most plentiful when conditions for growth are poor, that is during the winter and dry weather. No sign of any mildew or down has been seen on the leaf surface.

All sticks in a stool do not necessarily become infected, and it is common to see stools containing some healthy and some diseased sticks. When infection takes place in well-grown cane, that portion of the stalk below the site of infection usually remains healthy while the top develops typical disease symptoms, and side shooting occurs on the upper section of the stick.

Most varieties seem to be susceptible to the disease, but there is not sufficient information at this stage to decide whether some are more susceptible than others. The main factor concerned with the occurrence of the disease is flooding.

The disease is caused by a fungus which invades the plant tissues, and eventually forms large numbers of oospores, or resting spores, between the cells surrounding the vascular bundles. When the diseased plant is returned to the soil it decomposes, liberating the spores. The life cycle of this fungus has not been worked out, but by analogy with similar organisms it is probable that under very wet conditions the spores germinate to form free swimming organisms which are capable of infecting new plants. This fungus is closely related to *Sclerospora sacchari* which causes downy mildew disease in cane, but it does not form conidia on the leaf surface, as downy mildew does.

The origin of the disease is not known, but because of its wide distribution it is believed to be a parasite of native grasses which has adapted itself to cane. This year it has been found attacking wild sorghum (*Sorghum verticilliflorum*) in the Moreton area.

Fig. 2—Showing the spores in the leaf tissue magnified by 100.

Positive identification of the disease can be established by macerating a small piece of diseased leaf in 20 per cent. caustic soda solution for two or three hours, or longer. The material is then teased out on a slide and mounted in lactophenol with cotton blue. Examination with a high powered lens or microscope will show numerous spherical spores with their centres stained blue. As mentioned previously these spores are more plentiful at certain times of the year, and on occasions they may be difficult to find; however, during the cooler months of the year they are usually very abundant.

Control of the disease should not be a major problem since spread is confined to flooded areas. Diseased stools should be dug out and destroyed to avoid returning the spores to the soil. In areas where the disease occurs, planting material should not be taken from any crop growing on land which has been flooded.

Conference of Queensland Sugar Technologists

During the nineteenth Conference, which was held during April, several papers on agricultural subjects were discussed by the delegates and visitors who attended.

Some of these papers are reproduced in this Bulletin and those dealing with frost damage in the Moreton area and Chemical weed control under irrigated conditions should be of particular interest to many cane growers.

Another feature of agriculture day at the Conference was the presentation of coloured films and slides of the Bureau expedition to New Guinea. These depicted many scenes on the route followed by the expedition, showed the conditions under which the sugar cane collection was made and gave an insight into the way of life of New Guinea natives. Many of the places visited were, only a few years ago, in uncontrolled territory and the way of life in such centres is still unaffected by "civilization".

The audience showed considerable interest in this pictorial record of the expedition, the showing of which was accompanied by a running commentary by Messrs. J. H. Buzacott and C. G. Hughes. A lengthy discussion followed, and many questions relative to the expedition were directed to these officers. It was generally agreed that other parts of New Guinea as well as the neighbouring islands should, at some future time, be explored for further cane varieties to provide new blood for the Queensland industry.

During the week of the Conference the agricultural delegates spent a day at Ingham and another in the Ayr district. In the former area, they were the guests of the Herbert River Cane Growers' Executive and were given the opportunity of inspecting some of the Abergowrie lands. They were also shown over the Macknade breeding plots by officers of the C.S.R. Co. At Ayr and Home Hill, the various Mill Suppliers Committees arranged many visits to farms where various operations were in progress. Particular interest was shown in the mercurial dipping and spraying installations and in the circular saw method of cutting cane plants. All three of these new developments had their genesis in the Lower Burdekin district and the visitors gave due credit to the ingenuity of those growers responsible for perfecting them.

—N.J.K.

The Importance of Correct Fertilizing*

By L. G. VALLANCE

Rapidly mounting costs of production are a feature of present conditions in the industry. An item that is of considerable importance in this regard is the cost of fertiliser. The Queensland sugar belt is characterised by highly leached soils in which the plant food content occurs in varying proportions but usually one at least of the essential elements — nitrogen phosphoric acid and potash — may be deficient. Fertilizer usage is now practically universal in all districts and there is no gainsaying the fact that without adequate supplies our sugar industry would soon cease to exist.

Since its inception at the beginning of the century the Bureau has been particularly interested in the correct usage of fertilizer. Some of the very first trials set out were designed to test whether an improvement in yield could be obtained by the application of manures to the soil. Outstanding responses were obtained quite early in the history of these experiments and farmers, quick to perceive the significance of the results, rapidly became fertilizer conscious. The policy of farm fertility trials has persisted to the present day and as scientific technique developed the testing methods improved and became more accurate. Any refinements which could be adopted from the results of work overseas were made use of, and today it may be justly claimed that our sugar industry has a soil testing service which is as up to date as modern science can make it.

Strangely enough many growers seem to be unaware of this free service which is at their disposal, although every opportunity is taken to bring it to their notice. A check through the recrods of the past few years indicates that less than one grower in every ten evinces enough interest in his soil to have it tested. Possibly the more spectacular scientific achievements such as the breeding of successful new varieties, the overcoming of the grub problem and the control of major diseases have led his attention away from the question of soil management. Nevertheless the necessity for maintaining the fertility of his land is always present and to disregard it is poor policy, bad farming and—in the end—disastrous.

Over the years some hundreds of fertilizer trials have been harvested in practically all sugar districts. While not all of them have produced clear cut results the great majority have pointed conclusively to the fact that correct fertilizing pays. A trial recently completed in North Queensland very aptly illustrates this. The experiment was carried out over a complete cycle, i.e., plant, first and second ratoon crops. Some 27 different combinations of sulphate of ammonia, superphosphate and muriate of potash were used. The information obtained allowed a comparison of the monetary gain due to the various treatments to be calculated in detail. The figures quoted indicate the gain (or loss) above (or below) the return obtained from the plots to which no fertilizer was applied and refer to the total of the three crops harvested in 1949, 1950 and 1951. The ruling prices for cane according to c.c.s. content in those years were used to calculate the value of the tonnages harvested; fertilizer costs have been deducted and also the cost of cutting and transport of the increased crop. It might be pointed out that the figures do not represent net

* An address delivered to the Annual Conference of the Queensland Canegrowers' Association, Bundaberg, 1952.

profit because many such costs as planting, cultivation, etc., have not been taken into account since these would be incurred irrespective of the various fertilizer treatments. The following figures are sufficient to highlight the trend of the results:—

Fertilizer dressings			Increase in return Per acre for 3 crops
Sulphate of Ammonia	Superphosphate	Potash	
nil	single	single	£3 17 6
"	double	double	£1 15 0 (loss)
single	single	single	£29 15 0
"	double	double	£18 5 0
double	single	single	£88 0 0
"	double	double	£52 0 0
"	nil	nil	£14 10 0

When high amounts of superphosphate and potash were used without any nitrogen the fertilizer applications were of no value and actually returned £1/15/- per acre less than when no fertilizer at all was supplied. Conversely little benefit was obtained by using the larger dressing of nitrogen without phosphate and potash, the gain in this case amounting to only £14/10/- per acre over the total three crops. However, when the nitrogen, phosphate and potash were used in the required proportion the increase in return rose sharply to £88 per acre. This dressing which gave the best results was not particularly heavy, being approximately equivalent to about 3½ to 4 cwt. of Sugar Bureau Mixture No. 3 in the drill and a top dressing of a little less than 2 bags of sulphate of ammonia to the plant cane and 2½ bags to ratoons.

A matter of some satisfaction from an advisory point of view is that the above fertilizer mixture is the one which would have been recommended from the results of the analysis of soil samples taken from the block on which the trial was carried out. The amounts required as calculated from these analytical figures were, for all practical purposes, the same as those which were shown to be necessary by the actual yields of the trial. This is but further proof of the value of the service that is freely available to any grower.

I feel a little hesitant in stressing this to Conference since it is not new but has probably been taken for granted for so long that it has been forgotten. Perhaps it has been lost sight of in the hurly-burly of the present day scramble to make ends meet. Nevertheless the struggle of the industry to remain in existence is just as hard to-day as was the fight to become established early in this century. At that time close attention to the requirements of the soil paid dividends as it undoubtedly will at the present moment. I think that will become evident from a consideration of the following data. Figures accumulated by the Bureau some years ago show that millable cane contains the equivalent of 4.5 lb. of superphosphate and 3.1 lb. of muriate of potash per ton of cane. This refers only to that portion of the cane sent to the mill. Material such as trash and tops which also contain phosphate and potash are not taken into account since it is assumed that they are eventually returned to the soil. Let us consider what has happened over the last five years for which fertilizer usage figures are available. During the period 1946/1950 some 27½ million tons of cane were taken to the mill and this contained, in round figures, the equivalent of 55,000 tons of superphosphate and 38,000 tons of muriate

of potash. Over the same period the industry used 71,000 tons of superphosphate and 25,500 tons of muriate of potash.

These figures provide food for sober thought. In the first place the phosphate position may be regarded as satisfactory, although possibly a trifle wasteful. However, with regard to potash there is certainly no room for complacency, and we are faced with the inescapable conclusion that our soils must become depleted if we do not change our present methods. No bank, business or industry can continue indefinitely with a return of only 66 per cent. of its output and neither can a soil. I would recall to your minds the fact that in its last three Annual reports and from time to time in the Canegrowers' Quarterly Bulletin the Bureau has indicated that in the considerable number of soils analysed each year, potash deficiency is more marked than that of phosphate. Let us, therefore, use every means at our disposal to overhaul our present practices in order to attain efficient fertilizer usage.

Testing Sugar-Cane Varieties for Resistance to Leaf-Scald Disease

By C. G. HUGHES

The testing of all new varieties against the various diseases which occur or have occurred in various parts of the Queensland sugar belt is one of the major activities of this Bureau's Division of Entomology and Pathology. Although little publicised amongst cane growers in general it is a work which directly affects them, since the reaction of a variety to a particular disease can determine whether or not it will be released for commercial propagation.

It is true that many of what used to be important diseases are being brought under control but the necessity for testing varieties for resistance to these will remain for a long time to come and even when they have gone entirely a possible recrudescence will have to be guarded against. In addition, the continually changing varietal scene brings changes in the pathological problems to be faced, for it must be realised that many diseases are relatively rare at any one time only because the varieties then being grown are resistant to them. There was an excellent example of this with yellow spot disease in North Queensland in 1950 and 1951. The newer varieties such as Trojan and Eros are much more susceptible than the older Badila and the advent of these canes brought into prominence a disease hardly known in the older varieties. To prevent these damaging developments of what were uncommon diseases is one of the problems of the pathologist and the best way is to test all new canes for resistance to as many diseases as possible either by carefully planned trials or where that is not possible, through close observation during the years when the varieties are coming to commercial status.

LEAF-SCALD DISEASE

Leaf scald is a disease which has occurred in most areas of Queensland and in the Northern rivers of New South Wales. At the present time it is prevalent in the mill areas north of Townsville and is present to a lesser extent in the Moreton mill area in South Queensland. It has been found within recent years in fodder cane in South Queensland away from cane-growing areas, but its distribution in

the non-sugar growing districts is not known. In the north it is a major problem because several of the popular canes, e.g., Trojan, H.Q.426, S.J.4 and Q.44, are infected with it and sometimes are heavily damaged.

It is not proposed to detail here the symptoms of leaf scald and it will suffice to say that the outstanding features are a scalded appearance of the leaves, leaf streaks which often show a fine, white, clear-cut longitudinal line, shot buds, loss of vigour and frequent death of the stalk in susceptible varieties. Practically symptomless death of whole stools is also a feature of infected fields.

Fig. 3—Dead cane, the result of leaf-scald disease, left on the field after harvest.

The disease is largely confined to the wetter areas of the State and occurs particularly severely on badly drained farms or on those which may be rendered so by a long wet season. It does not normally spread on the higher, well-drained lands and diseased stools tend to die out more readily there than in the wetter country, although with highly susceptible varieties heavy losses may occur wherever diseased material is planted.

LEAF-SCALD RESISTANCE TRIALS

The disease is caused by bacteria which exist not only in the leaf streaks but also in the juice of infected stalks. The disease can be transmitted readily by inoculating this diseased juice into other plants. It can be done by pricking the leaf surface with a needle through drops of the infective juice or by inoculating it into the stem with a hypodermic syringe. Another way is to cut alternately diseased and healthy stalks so that the bacteria are transferred from one to the other in the juice adhering to the cane knife. This is a method which has been used in Java in conducting disease resistance trials, but in Queensland and Hawaii a slightly different procedure has been adopted.

The inoculum in these trials consists of juice from diseased stalks fortified with a suspension of bacteria from a culture grown in the laboratory. This ensures that there are large numbers of bacteria in the inoculum. The actual inoculation in

Queensland is made by pressing the freshly cut ends of the 3-eye setts firmly on to a small cup-like structure of stainless steel screwed to the bottom of a container holding several ounces of inoculum. The level of the inoculum is just above the sharp edge of the cup and as the cut end is pressed down the pressure forces the juice up into the sett at least to the first node and sometimes beyond. By this method a concentration of scald organisms is pushed into the sett ahead of any organisms which may invade the tissues after the sett has been planted in the ground.

In some varieties setts containing the organisms do not germinate as well as healthy setts and in order to obtain a measure of this effect, a comparable series of non-inoculated setts is planted in the trial. Usually 50 setts of each variety are inoculated and either 25 or 50 in 25-sett plots of non-inoculated are put in as controls. The plots are single row and for ease in planting all plots of each variety are put in the one row.

Each trial includes, of course, several varieties, the reactions of which are well known in the field. These range from fairly resistant varieties to those known to suffer severe losses under commercial conditions. Varieties in the latter category are H.Q.426, Q.44 and Trojan, and any variety showing more susceptibility than any of these three would not be released in a diseased area.

The choice of sites for a scald trial is as important as with any other disease if reliable results are to be obtained. It goes without saying that it must be readily accessible to the pathologists, that it receives adequate cultivation and that it is not a danger to neighbouring cane farms. In addition, however, the ability of the disease to remain masked for long periods under good growing conditions renders it imperative that the trial be conducted in a locality where comparative lack of soil moisture will interrupt growth from time to time. For some years the trials were conducted on the dry foothills near Hambledon

Fig. 4—Another photograph of a leaf-scald diseased crop. All the stalks left standing were dead.

mill; later they were shifted to heavy clay soil near Fishery Falls at the southern end of the Mulgrave mill area; within recent years they have been moved to the Bureau's Pathology Farm near Brisbane.

The selection of a trial site in such a position that it would be expected that growth of the cane would be discontinuous means that natural spread of the disease cannot be expected. The natural methods of spread are not known at present, but as mentioned above they apparently do not operate on the better drained soils. The lack of spread renders the interpretation of trial results very difficult and conclusions can only be drawn from a close study of the behaviour of the individual plants. The effect of inoculation on germination may or may not be an important feature depending on how much disease develops in the variety. Some canes, for instance, suffer a depression in germination, but the surviving stools are healthy and the variety usually proves to be quite resistant commercially to the disease.

A variety producing a good germination of healthy stools is regarded as resistant to the disease and an undue proportion of diseased stools indicates susceptibility, but there is a large range in between these extremes which needs a considerable knowledge of the disease to interpret as regards resistance or susceptibility.

Stools affected with leaf scald do not all die and the course of the disease in individual plants has much to do with whether a variety showing some disease can be classified as commercially resistant. If the majority of the diseased stools die soon after germination or fairly early in the crop, the variety tends to free itself of the disease and it will not suffer losses from the disease. If, however, the diseased stools do not die or, worse still, appear to recover completely, one is faced with the possibility that the variety will maintain the disease indefinitely and that whenever unfavourable growing conditions occur the disease will cause serious and unexpected losses.

THE RESISTANCE OF APPROVED VARIETIES

Information gained from observation of leaf-scald disease in commercial plantings as well as from disease resistance trials has been used in drawing up the list of reactions of approved varieties to the disease. The varieties may be divided into four classes ranging from a group in which the disease is rarely seen to one whose members will show serious losses if grown in the presence of the disease. The groups are detailed below:—

Group:

1. Highly resistant; may be grown in the presence of the disease without precautions.
2. Intermediate; may be grown in the presence of the disease with suitable precautions.
3. Susceptible; liable to suffer losses from the disease in an adverse season.
4. Very susceptible; suffers losses in most seasons.

Varieties:

1. Atlas, C.P.29/116, Comus, D. 1135, Eros, Pindar, P.O.J.2725, P.O.J.2878, Q.50, Q.813, Vesta.
2. Badila, Cato, Korpi, M.1900 S., Pompey, P.O.J.2714, Q.10.
3. E.K.28, Orion, S.J.4, Trojan.
4. H.Q.426, Mahona, Oramboo, Q.44, S.J.2.

Chemical Control of Weeds on an Irrigated Farm at Bundaberg*

By E. H. CHURCHWARD

While farmers have in the past successfully used 2,4-D for the control of weeds and grasses in their sugar fields there was no immediate evidence to hand that it could be used with such ease and success under irrigated conditions. With the co-operation of the Bureau of Sugar Experiment Stations a 3 row pre-emergence trial was set out under irrigation on the writer's farm at Gooburrum on 14th February, 1951. The block used was red sandy loam soil with a gentle slope.

Two days after the cane was planted the drills were cotton kinged and the spinner put through to break down the sides of the drills so as to prevent any heavy rains from washing too much soil on to the plants. The 2,4-D was applied at the rate of 3 and 4 lb. per acre in adjoining sections. The row on either side of the trial was left as a check on the amount of germination that would normally have taken place and the rest of the block received normal farm cultivation treatment.

Grasses and weeds germinated and grew profusely in the check rows in spite of the fact that no rain of any consequence fell. In the trial area control was very good throughout the full length of the rows (see Fig. 1). The few weeds that germinated and showed any signs of growing were contact sprayed and consequently died. A few isolated plants of crowsfoot and summer grass appeared but they remained crippled and extremely stunted.

After approximately 10 weeks the whole block was flood irrigated owing to drought conditions. The sprayed area remained weed-free whereas the rest of the block had to be weeded on 10 occasions in all, including the chipping of any isolated tufts of grasses which evaded the cane cleaner, cotton king, spinner and scarifier. It was noticeable very early that the sprayed rows were showing much better growth than the rest of the block and they have continued to do so right up to the present time. Better moisture and tilth were noticeable in these three rows. No effort was spared to force germination of seed as the trial received normal irrigating. Although a very large flow was used to try and cause soil movement and at times a trickle of water was left running in the top end for up to two days the results have remained satisfactory. On the headlands the grasses have been extremely vigorous while in the check row they have reached choking proportions. For any farmer desirous of irrigating down the stools this trial has proved that cane may be planted, grown and harvested without any further mechanical treatment after the application of 2,4-D, with the added financial gain of more cane per acre owing to each watering being more efficient.

In spring of 1951, the writer had the pleasure of seeing the application of 2,4-D under irrigated conditions carried into the commercial field. From the 6th to the 12th September a 16 acre block of Vesta cane was planted in red volcanic soil and watered to ensure germination. It was then cultivated, and on the 15th October, the day after 28 points of rain had fallen, it was sprayed with 2,-4D. On the 5th and 6th November and again on 6th to 8th January it was irrigated and is an outstanding

* Paper presented at the Conference of the Queensland Society of Sugar Cane Technologists.

example of successful chemical control of weeds and grasses under irrigation. Immediately after the first watering the main drain was hand sprayed and it, too, is perfectly clean. Approximately 6 to 10 grass seedlings germinated per chain of row, but these produced only one root and remained crippled.

place. The results were very good in all eight rows and even after four months the few weeds which had germinated were very stunted through their contact with 2,4-D.

As is so often the case the interspace of two rows of the block had to be used as main drains. A month after these two rows had been sprayed

Fig. 5—The control achieved by spraying with 2,4-D. The rows on the left of the untreated row were sprayed; that on the right was cultivated.

In another instance an eight row block was planted on September 12th and watered for germination; within 24 hours of watering six rows were machine sprayed while the two remaining rows which had a main drain through the interspace were hand sprayed approximately 72 hours later, after some germination had taken

they had approximately 40,000 gal. per hour running through them for three days. Because of two subsequent waterings of the neighbouring block these rows had large volumes of water running down them for nine days in all, but with the exception of a few bell vines they remained perfectly clean.

Further interesting results were obtained on a block of ratoon cane which had received normal cultivation after being cut and where, in addition, water furrows were placed down the interspaces. In extremely dry and dusty conditions, 2,4-D was applied as all other blocks were treated. A couple of days later every second interspace was watered so as to cover a larger area per day. Approximately a month afterwards, the alternate rows were watered and in these rows, although there had not been any rain in the interval, the control was fair. However, the interspaces which had been irrigated at the first watering produced pig weed in large quantities and also a fair quantity of summer grass. This latter did not remain stunted but outgrew any damage the 2,4-D might have caused and reached proportions demanding attention. Where the soil did not come into actual contact with the water the control was excellent.

In view of the good results previously obtained under irrigation this partial failure is somewhat difficult to explain. Possibly the extremely dry dusty conditions were followed too closely by water but whatever the cause may have been the writer prefers that the problem be left to the very co-operative and capable Bureau officers to ponder. Be the reason what it may, the problem is far from insurmountable for the position may possibly be rectified by the use of contact sprays. For such a purpose a second boom could be made to fit on the tractor and, instead of having the droppers set out to spray the whole of the surface of the stool and interspace, would have a dropper set to spray directly up the water furrow. Immediately the weeds in a block showed signs of not being satisfactorily controlled they could be sprayed when very small with some contact spray which would reduce them to ground level. At the moment the writer believes that either a creosote base material or a Vacuum product combined with a proportion of 2,4-D appears as though it might accomplish satisfactory results. These experiments have not yet been conclusive enough to propose a definite mixture but the author has no doubt that the industry's technicians will be equal to this task in the very near future.

Driving across the main drains offers some discomfort and subsequent interference to the booms which, in crossing a deep drain, may dip into the soil. This may be overcome by first going down the interspaces which the tractor travels and placing sufficient soil in the drain to form a bridge for the tractor to drive across. This will allow continuous and more efficient spraying while crossing the drains.

In summarizing observations on the area of cane under irrigation with which he has had actual experience, the author has no hesitation in saying that any farmer wishing to control weeds chemically on forest or red volcanic soils free from nut grass can do so with every confidence that he will achieve either perfect or satisfactory control. If through any peculiar circumstance he gets slight germination he can gain control by the use of contact sprays. This is no doubt a very favourable position for a farmer, for instead of having to cease irrigating either after one watering or after slight rain in order to weed cane mechanically he can, if he so wishes, continue to irrigate. Where there is a steep grade and watering on the stool is desired he can expect larger crops owing to a better body of cane leaf slowing down the velocity of the water. Very briefly, the method is agriculturally and economically sound.

Leaf-Scald at Moreton

By C. G. HUGHES

Leaf-scald disease has been known in Queensland and northern New South Wales for a long time and many of the older generation of cane farmers will remember how it caused serious losses in the days when Mahona was a popular cane. Within recent years, however, it has been generally confined to North Queensland, although in 1949 it was found to be causing losses in a cow cane in dairy country near Nerang, S.Q. It was nonetheless surprising to find it a few months ago in the Moreton district, for the last record of it there was nearly 20 years ago. The severe drought during the latter half of 1951 prevented normal growth in the crops in the Moreton district and when inspections were made in February and March of this year very little cane had been formed by the standard varieties. The disease was first identified in two Bureau seedling canes which were growing in small plantings on the Maroochy River. Plants of these had come through the Beerwah isolation plot from the Bundaberg Experiment Station, where the disease had not been seen since 1928, and there was absolutely no evidence that the seedlings had been infected when planted. On the other hand, a brief survey of the district showed that the disease was fairly widespread, although nowhere causing heavy infection, and there is no doubt that the seedlings had contracted the disease from some Trojan planted at the same time.

It is possible that it persisted in odd blocks of the susceptible Oramboo which has only recently disappeared from the scene, or perhaps, since the disease is known to occur in a very inconspicuous form in certain varieties, it has persisted in a variety or succession of varieties awaiting as it were the introduction of a susceptible seedling or variety.

It is fortunate that at the moment the disease is not a serious threat owing to the comparative resistance of most of the popular canes and the fact that the susceptible Trojan is being discarded by the farmers. The discovery of the outbreak does mean though that in future all canes for testing at Moreton will have to prove their resistance in leaf-scald trials just as those for the northern mill areas already do. In addition, particular care will have to be taken to make sure that the amount of disease in the district does not increase and that fields now clean continue to remain so. This involves the sterilizing of all cane knives when moving from one field to another when cutting either cane or chop, for the disease is caused by a bacterium which can live in the juice on a knife. Knives can be sterilized by dipping in a solution of a disinfectant such a "Lysol" or by wetting with methylated spirits and lighting with a match.

It is not intended to give a description of the symptoms of leaf scald here, but any farmer seeing scalded leaves in a wilted stool is asked to notify his district Bureau officer or Pest Board supervisor without delay. The disease can cause serious losses and early discovery of the disease is more than half the battle.

Velvet Beans

By NORMAN J. KING

Several previous articles on the subject of green manure crops have stressed the value of velvet beans as a cover crop on cane farms during the fallow period. In the past two years a deal of further information has been obtained in most districts under both favourable and unfavourable conditions.

Fig. 6—A young velvet bean crop planted in rows. The interspaces can be left clean until the runners have covered the ground.

The fact that many growers have not given a trial to this very valuable legume is made evident by the number of complaints being received of the effects of wilt on cow-peas. So far velvet beans have stood up to bean fly and to the various wilts and have performed well under both wet and dry conditions from Nambour to the far North.

Velvet beans were looked upon with suspicion by northern growers who had recollections of the Mauritius Bean which germinated irregularly because of a proportion of "hard" seed and which came up in the succeeding cane crop and formed an obstacle to cultivation. The velvet beans being grown to-day germinate evenly and do not cause any trouble after ploughing in. Growers who have examined velvet bean crops are unanimous in their opinion that no other green manure crop gives the same body of material; they also agree that velvet beans give a reasonable crop under dry conditions when cow-peas die out.

Since the first trials with this species the Bureau has recommended sowing of seed in rows rather than broadcast. Velvet beans are rather slow starters and if sown broadcast a block tends to become dirty with weeds and grasses. Sowing in rows four feet apart, be-

sides saving seed, allows a high speed tractor to run between the rows and to keep the ground clean until the vines are covering it. Sometimes only one cultivation is necessary.

During the summer of 1951-52 several blocks were sown on the Bundaberg Experiment Station—some in rows and some broadcast. Even in this dry summer grasses soon made the broadcast blocks very dirty, and the competition for moisture was obvious; the drilled blocks were considerably ahead of the broadcast ones. When the March rains broke the long drought all blocks made rapid headway but the broadcast ones failed to make up the leeway.

Fig. 7—A bunch of velvet bean pods. This variety is a prolific seed producer.

Growers are urged to give more consideration to velvet beans as a soil improver, as a soil cover during the hot, wet summer months and as a supplier of nitrogen to the plant cane crop. They are long past the experimental stage in Queensland and can be depended upon to give a favourable crop on any soil type producing cane. Naturally, as with all leguminous crops, they do not like acid conditions and do best on non-acid soils or where lime has been applied to correct soil acidity.

Fig. 8—The grown crop. Such a field would carry 16 tons per acre of green material.

The Eradication of Downy Mildew in the Bundaberg Area

By N. COURTICE

The early history of downy mildew in this area is obscure, but its existence at a very early period has been verified by many old growers. The kanaka worker of those days aptly referred to downy mildew as "jump-up". This name described a stage in the development of the disease when a proportion of infected stalks suddenly grew several feet above the surrounding cane.

We know nothing of the intensity of the disease at that period but it seems probable that, "survival of the fittest", i.e., survival of the more resistant varieties, was one factor in keeping it in the "nuisance" class.

Farmers then had the doubtful benefit of a wide range of varieties from which to choose and would discard susceptible canes for those showing more resistance. The existence of buffer areas of standing timber and other crops when the district was less highly developed also minimised the spread of the disease. The association of some of these older growers with this phase of downy mildew might account for the apathy of some of them when circumstances later converted the "nuisance" into a "menace".

The introduction of P.O.J. canes in 1933 put a rude ending to this former status of downy mildew in the Bundaberg district. These highly susceptible canes were particularly suited to this district, especially P.O.J.2878. Not least among the desirable points about this cane was its standover qualities. During this period proportionate harvesting was the district practice and the ability of P.O.J.2878 to standover greatly enhanced its value. This, therefore, created "made to order" conditions for the spread of downy mildew. Subsequent events proved the opportunity did not go begging.

In 1937 Bureau Officers noticed a sudden increase in downy mildew infection and by 1938 the position had deteriorated alarmingly. In that year the Bundaberg Canegrowers' Executive appointed the writer and another inspector to assist Bureau Field Officers in a campaign of eradication. Three additional men were appointed later. A great deal of disease was dug out but it soon became clear that a much greater effort was called for if we were to make any appreciable progress.

In May, 1939, the Bundaberg Cane Disease Control Board was formed. Members of this Board attacked the job with vigour. They immediately appointed three inspectors, each with a gang of four or five men. The district was zoned, each having a gang. This zoning was not rigid, for gangs were switched to any area where circumstances warranted. The Chairman of the Board, the Secretary, Bureau Officers and Inspectors met and still continue to meet in conference every Saturday to discuss detailed reports of work done. This close contact by all directly concerned with the work has been the means of providing an over-all picture which no amount of mere figures could convey.

It is beyond the scope of this paper to record all the aspects of downy mildew and its control, but some of the happenings in the field may be of some interest. Of the many obstacles to control we found that one of the worst was the appearance of disease symptoms in the one block over a considerable period. This often meant several inspections had to be made before the block could be written off

however slightly it may have been infected. Another hindrance was the existence of so much standover. Healthy young cane near these blocks became infected and re-infected as fast as it was cleaned up. The restriction of standover to blocks known to be disease-free rectified this. At this time, prior to the introduction of approved fodder canes many farmers retained small areas of cane for stock feed. These were cut after harvest-time, December to April, which is the peak period of downy mildew spread. When this feed was cut the very young ratoons often showed very heavy infection.

Of course the Bureau was fully aware of this risk of downy mildew in ratoons from late-cut cane, and they insisted that wherever practicable infected blocks be cut reasonably early. This enabled inspections to be carried out before any disease in the block had time to spread. This was an important feature in the control of this disease.

Another aspect of infection involving young growth, this time from side shoots, was shown in an incident in the Qunaba area in a three-acre block of Q.48. Although it was in a heavily infected locality, Q.48 had shown resistance and had a clean record. A small cyclone struck the area and our next inspection revealed 70 downy mildew stools. Without exception the symptoms were showing in side-shoots from broken-off sticks. Up till the time it was harvested we were unable to find downy mildew in an undamaged stalk.

The writer recollects inspecting 35 diseased blocks in succession; when the next field proved clean one of the gang was induced to remark "some one has beaten us to it".

By October, 1939, downy mildew had been found on 167 farms and nine plantations. This record might prompt the query "why was P.O.J. 2878 not disapproved immediately?" Such action, desirable as it may have seemed from a disease control angle, would have resulted in the cure being worse than the disease. In 1939 it was estimated that the variety P.O.J. 2878 had added £300,000 to the value of the crop for that year above.

The table below indicates the number of stools dug out since the work began:—

Year.	Stools dug out.
1938	4,233
1939	12,581
1940	13,235
1941	3,734
1942	999
1943	1,650
1944	4,008
1945	1,406
1946	5,270
1947	1,801
1948	725
1949	74
1950	7
1951	0
1952	0

Up to 1941 the decline was rapid, brought about to no small extent by a number of plough-out orders. By this time many of the smaller isolated areas had been cleaned up. In the Woongarra, which had always been the main centre of infection, the disease fluctuated with annoying persistence. When reviewing the value of the work it should be remembered that downy mildew was not the only problem with which the administration had to contend. Fiji disease was rampant in many parts of the area, often occurring in blocks free of downy mildew. The campaign against Fiji disease is another story but the presence of one influenced the work on the other.

During the war years the Board lost many of its best men and the work suffered accordingly. The degree of control obtained by roguing diseased stools was influenced largely by weather conditions. Prolonged dry spells enabled us to concentrate

our efforts upon diseased fields with the knowledge that no spread was taking place in the meantime. During the drought of 1946 many diseased fields were cleaned up permanently. On the other hand, many blocks of young ratoons, particularly those from fields harvested late in the season became hopelessly infected during short spells of moist humid conditions.

After 1946, the amount of downy mildew showed a definite downward trend. This coincided with the reduction in acreage of the susceptible P.O.J.2878 and the introduction of the resistant C.P.29-116. Just as P.O.J.2878 was responsible for the upsurge of downy mildew, so C.P. 29-116 was responsible for its decline. The planting of this latter variety created buffer areas which cut down the spread from diseased fields and narrowed down the area of susceptible cane, enabling us to concentrate our efforts on a greatly reduced area. Thus again it was demonstrated that the best cure for cane diseases is the extensive use of resistant varieties.

The last recorded stool of downy mildew was dug out in March, 1950. The importance of eradicating a disease rather than just keeping it under control will be obvious to all growers. While the Board hopes that future events will not prove the title of this paper over optimistic, it is not adopting any wait-and-see policy. It continues to maintain a constant patrol of the district.

During their stay, the members of this conference will have the opportunity of visiting the downy mildew disease resistance trial plot at the Elliott River. They will see how some of their own district canes fare when exposed to the disease. The value of this testing plot as an insurance against the introduction of a cane susceptible to downy mildew will be apparent.

I am informed that it is the Bureau's intention to transfer this trial to Brisbane, a decision influenced, no doubt, by the eradication of downy mildew in the Bundaberg area.

Supplies of Velvet Bean Seed

During the course of the Annual Field Days held at Meringa and Mackay during May a large number of growers evinced a decided interest in the crops of velvet bean which were seen on those Experiment Stations. Another article in this Bulletin deals with the good points of this particular green manure crop and the Bureau has been recommending it to growers in all areas for three or four years. Undoubtedly much larger acreages would have been planted in the past had adequate seed supplies been available, but there has been a shortage of this variety as well as of all other green manuring types.

The Bureau has distributed considerable quantities of seed to growers at various times and has advised them to collect seed pods from the mature crop and thus ensure their own seed supplies at least. Unfortunately, very little seed has been collected in this way and each year witnesses a greater demand, but no increase in supply. The commercial seed growers do not evince much interest in this variety and our efforts to have large plantings made in Kingaroy, the Lockyer and the Atherton Tableland have not been successful. Growers' Executives could do much to assist the industry by sponsoring this project with commercial seed producers.

In the present year we have advice that there will be good supplies of seed available in the Childers district and interested growers are urged to address their enquiries to the Isis District Canegrowers' Executive.

—N.J.K.

Some Observations on Frost Injury to Sugar Cane—Nambour Area

By N. McD. SMITH

INTRODUCTION

During July and August, 1951, south-eastern Queensland suffered abnormally severe frost visitations due to unusual movements of cold, dry air from the south-west. The air stream had travelled northwards from the polar regions precipitating moisture on the southern heights. As it reached Queensland its direction changed to easterly, wind velocities moderated, and the dry cold air mass remained. The squally winds active at the time kept the ground dry and cold, so that during the intervening quieter lapses, radiation frosts were severe and occurred in areas usually outside the frost belt.

When it became apparent that weather conditions predisposed frosts it was decided to observe the effects of injury on some of the commercial varieties of cane, and weekly samples of four varieties from six fields were obtained. The varieties selected were: C.P. 29/116 (P.O.J.2725 × C.P. 1165), Q.47 (Co.290 × P.O.J.2878), Q.42 (Co. 281 × Q.33) and Trojan (Co.270 × 27. M.Q.1124). The first two are light coloured and the others dark.

GENERAL

The Nambour cane-growing lands consist mostly of recent alluvials and reclaimed tea tree (*Melaleuca* spp.) swamps which lie to the east of the main northern railway line. These low-lying types occur along the banks of three streams which run more or less parallel towards the sea. The remainder of the area comprises elevated sands and elevated gravelly clay loams. Frosts are usually more frequent and severe on the organic silty loams of the tea tree lands than on the light coloured soil types.

Low temperatures were general in early June and the first extensive damaging frost occurred on 23rd July, being preceded by two less severe ones on consecutive mornings. Damage extended over the area occupied by the alluvial soil types and, in some cases, where timber ran across a slope, frost reached almost up to the timber line. Symptoms of damage in the foliage were apparent by midday in those localities worst affected. Observations made one week after the 23rd July showed that damage occurred on the areas normally most subject to frost and also on those immediately adjacent.

The second damaging frost occurred on 13th August and although its severity was comparable with that of the first, it caused greater damage to the cane. The principal factor responsible was probably the reduction of ground coverage and "blanketing" effect due to leaf damage caused by the first frost.

FROST DAMAGE SYMPTOMS

In a reasonably vigorous crop, the foliage is the first portion to be affected by a frost of a light to heavy nature. The initial symptom is a slight water-soaked appearance of the ground tissue which finally bleaches, producing a striped appearance as illustrated in Fig. 9. This is accompanied by browning of the leaf tips with consequent rolling (or spiralling) and subsequent loss of ground cover.

It often happens that preceding a frost there are periods when the temperature will have fallen to slightly above 32° F. Harm will result to that portion of the tip which lies within the cornucopia as the low temperature of the water which is almost always present, will be sufficient to kill

chloroplasts and most likely a small area of tissue, the later usually occurring towards the margin of the leaf. The final symptoms are bleached bands on the basal portion of oldest leaves and towards the tip of younger leaves. The symptoms, known as "banded chlorosis" are illustrated in Fig. 9 and 10.

Should temperatures reach freezing point, damage to the spindle occurs and is first apparent as a water-soaked area slightly above the growing point of the stalk. As decomposition progresses the area darkens to almost

follows a "killing" frost but there is a marked varietal resistance as illustrated in Fig. 11 in which two varieties under similar conditions are compared. The Trojan has resisted damage to the growing point and eyes, whereas both regions of Q.47 have been killed.

As further elongation of the stalk ceases due to the death of the growing point, sideshooting follows and the uppermost sound eyes of the stick will make millable stalks as a stand-over crop under favourable conditions. In this connection there is a quick response by some varieties to death of

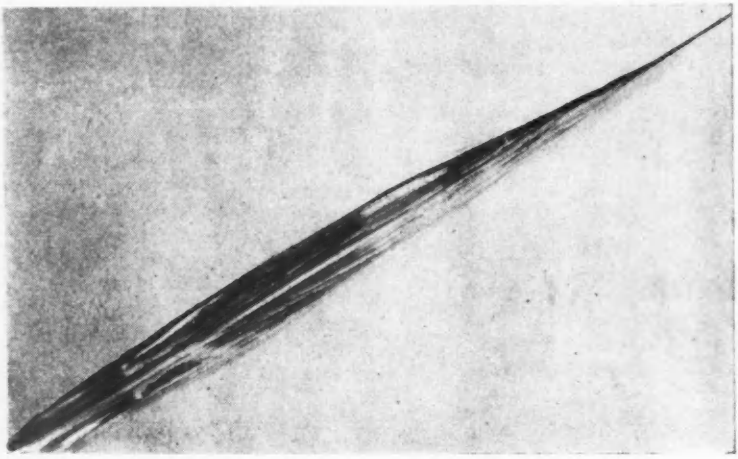


Fig. 9—Chlorosis with leaf striping on Trojan.

black, collapses, and the whole spindle may be drawn out with little trouble. This conditions is known as "heart damage." It must not be confused with death of the growing point which is illustrated in the stalks of Q.47 as shown in Figs. 11 and 13. It will be noted in Fig. 11 that the growing point of Trojan is sound and will continue normal elongation with production of a new top when conditions are suitable. However, in this case, there would be a noticeably pinched appearance in the region of the injury, giving a "lady's waist" effect to the stalk. Death of the growing point

the growing point. Q.50 (P.O.J.2725 × Co.290) produced swollen eyes within one month of the growing point being killed and was thus rendered quite unfit for planting material. At the other extreme the buds of N.Co. 310 (Co.421 × Co.312) and Trojan under similar conditions had not moved six weeks after the apical bud had been killed and, with careful selection, provided sound planting material during the period. In passing, it may be mentioned that plants of Q.50 are in demand because of certain desirable agricultural features of the variety, but this year eye swelling

and shooting caused by frost predisposed them to damage and much cane was consequently pronounced unfit for plants.

Temperatures low enough to kill the apical bud of the stalk also injure leaf tissue considerably. Shortly after thawing the initial signs are observed as a general water-soaked appearance of the ground tissue with the fibro-vascular bundle arrangement retaining a faint greenness. Generally at this stage the damage is most noticeable for two-thirds of the leaf. Overall, the whole leaf assumes a bronzed colour which finally changes to brown and the oldest leaves fall away at an angle from the spindle. In only the most severe cases of frosting does all the leaf become brown. Generally the basal portion, although discoloured, has some green tissue surrounding the veins and a striping as shown in Fig. 9 and 10.

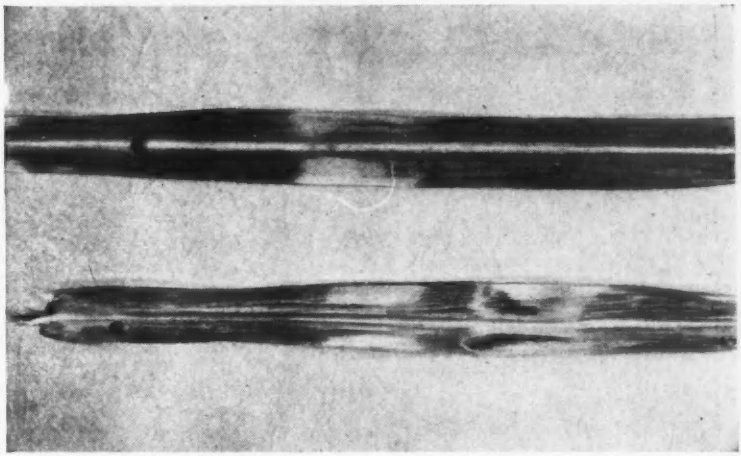


Fig. 10—Further illustrations of banded chlorosis and leaf striping.

In regard to the detection of frost injury in the selection of suitable planting material it was found that the usual farm practice of removing eyes with a fingernail or excising with a knife was misleading. The only positive way of determining the condition of an eye was found to be a close inspection of a radial longitudinal section through the stalk and eye. Referring to the eye illustrated in Fig. 12 which appeared on external examination to be undamaged, it will be seen that in section a dead area exists at the point of elongation and the bud is therefore incapable of growth. In this particular instance the eye had developed a little and field experience indicated that such an eye may lengthen to ½ inch and then wither because no further growth can proceed. Figures 14 and 15 further demonstrate this point and show the extent to which an eye as pictured in Fig. 12 may grow slightly and even appear sound on external examination. In determining condition of eyes it must be pointed out that in many cases experience is required to differentiate between the colour of dead tissue, and that which has become brown due to exposure of the section to air and the consequent discolouration of the tannins.

The practice of stripping trash from the standing stalks to harden eyes and reduce labour is not considered at all wise when weather conditions indicate

frosts. It follows that the removal of the old leaves will permit of lower temperatures at the height of the exposed eyes because warmth from the ground is not retained by the protective overhead canopy. There is a further grave risk in allowing cane stripped ready for planting to lie overnight in a frosty locality.

Under the dry conditions which prevailed during the period of observation, stalk decomposition was slow. This was expected since such conditions were not conducive to microfloral Q.42 and C.P.29/116 following the August frosts and after damage had been sustained in July. It is interesting to note that Q.42 has resisted decomposition, for each node appears unharmed although the eyes are dead. On the other hand, C.P.29/116 shows pronounced "piping" and decomposition at all nodes. It would appear that the rate of stalk deterioration following frost is dependant on variety, and perhaps this fact is associated with a function of the nodal tissue in resisting attack by fungi.

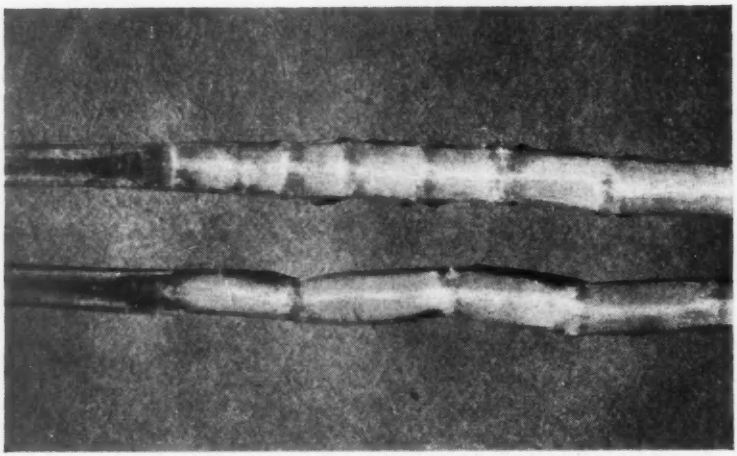


Fig. 11—A stick of Trojan (top) and one of Q.47 (below). The former shows greater resistance to bud damage and growing point injury.

or chemical activity. However, it was noted, as illustrated in Fig. 11 and 16, that the dark rinded canes under discussion proved more resistant to internal tissue damage than the green stalked types. The Trojan, illustrated in Fig. 11, has not suffered the damage to the apical point as had Q.47 and this may also be said concerning eye damage. Actually, the dark appearance of the Trojan's growing point is due partly to exposure to the air of the tannins found in the assimilating parts of the plant. Whilst Fig. 11 shows comparative varietal conditions following the July frosts, Fig. 16 shows

VARIETAL RESISTANCE

The nine major varieties of the area were assessed in relation to susceptibility to damage of the foliage, eyes and the rate of internal tissue deterioration of the stalk. The groupings are shown in Table I with Q.42 as the standard frost resistant type.

OBSERVATIONS ON C.C.S. AND FIBRE CONTENT

The period of observation commenced on 27th August, and seven weekly samples from six fields were obtained. Twelve sticks were selected from each field and were later halved,

six whole sticks being tested for C.C.S. and the others for fibre. Rainfall totalled 254 points over six wet days and, as the total July fall was only 9 points, near drought conditions prevailed.

TABLE I.

Variety	Foliage	Eyes	Stalk Deterioration
C.P.29/116	+−	−−	−−
Pindar	−	+−	−+
Q.28	+−	−	−
Q.47	−	−	−
Q.50	−	−	−
Trojan	−−	+	+−
Vesta	−	−	−
N.Co.310	+−	+	+−

+− equal to. + better than. − worse than.

As the degree of frost injury varied between some of the samples the results will be viewed individually and the stalk condition of each described. Overall, there was not a rapid physical deterioration of stalks; the highest rate of deterioration during the seven weeks coincided with the short spell of steamy weather following the 87 points of rain in the fifth week.

Fig. 13—A dead growing point in Q.47, ten days after damage.

Fig. 12—Section of a damaged eye, showing that growing point has been killed.

Graphs of the weekly changes in C.C.S. and fibre contents during the period are shown in Fig. 17.

Samples No. 1, 2 and 3 are grouped for they were selected from two adjacent fields of Q.47 and Trojan. Samples No. 1 and 3 (Q.47) represent a field which comprised two terraces, the lower being very subject to frost and the other only slightly so. The extent of injury to Sample No. 1 on the higher terrace amounted to death of growing point, whilst the other had been further damaged to the extent of all eyes to half way down the stick. Their respective C.C.S. curves show a steady rise of about 1.5 units to the fourth and fifth weeks. Following

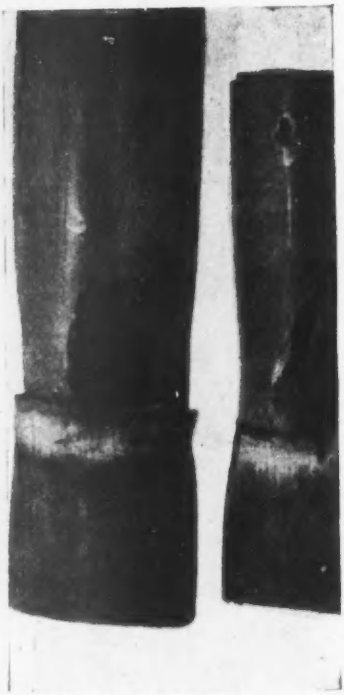


Fig. 14—Apparently healthy shoots found on examination to be dead.

rain there was a sudden drop of over 2.5 units, but this was recovered in the final week of test. The fibres remained fairly constant, the greatest weekly variation being 0.6 per cent. In both cases there was some production of sideshoots, the most vigorous of which, during the last two weeks, were leafed. Although damage to both samples, and especially to No. 3, was severe, stalk rotting did not proceed further than the first fully lengthened internode. (The specimen of Q.47 in Fig. 11 was taken from the lower terrace and the damage is illustrated.) The Trojan shown in Fig. 11 illustrates the injury suffered by the crop on the adjacent field and indicates the state of Sample No. 2. In comparing the curves of Samples No. 1, 2 and 3 it is apparent in the case of Trojan that there is a slow downward trend on the C.C.S. graph whilst the reverse holds for the green stemmed Q.47. The fibre determinations show a slow increase of one unit for the Trojan and a slow loss for Q.47. The reasons for the behaviour of Trojan are believed to be associated with the severe damage sustained to the top. The variety is very sensitive in the foliage to cold conditions and the first series of frosts caused death of the leaf except for small areas near the base of lamina and spindle. Loss of chlorophyll together with reduction of shading are considered to be the factors contributing to the loss of C.C.S. and the gain in fibre.

The consideration of Samples 4 (C.P. 29/116) and 5 (Q.42) is interesting as they were taken from the one field. In the first place the block was planted with Q.42, but a poor

Fig. 15—Same as Fig. 14. These shoots, when cut in section, are found to be dead.

Fig. 16—Showing the difference in varietal resistance to stalk deterioration. Q.42 (left) and C.P.29/116 (right) taken from the same field.

germination resulted and the "misses" were planted with C.P.29/116. The proportion of each variety in the spot from which the samples were selected was calculated at 41 per cent. C.P.29/116 and 59 per cent. Q.42. The varieties received very severe frosting as the field is situated in a position which is liable to low temperatures in any year. (The condition of the canes is shown in Fig. 16, and the respective resistance to damage and rotting may be noted.) The The graphs concerning these two samples show a maintenance of C.C.S. by Q.42 for four weeks with a slow fall for two weeks and a severe drop for the last week. The fibre varied slightly throughout with a difference of 0.6 per cent. between the first and last tests. It appears that C.P.29/116 generally maintained its C.C.S. value for the seven weeks. Its fibre increased from the fourth week and rotting, with consequent drying out, was hastened by the rain in the fifth and sixth weeks.

Sample No. 6 was obtained from one of the coldest fields in the mill area. This crop of C.P.29/116 was estimated at 10 tons per acre, when frosted in early July. Later injury killed all the eyes and foliage so that it was anticipated at the commencement of the tests that the stalk condition would deteriorate to the extent that further sampling would be impracticable. However, the dry weather appeared to assist in maintaining its condition and the last parcel of sticks showed internal stalk rotting only down to one-third from the top.

The poor condition of the cane is reflected in the low C.C.S. values shown by the curve; although this fluctuates somewhat, it was not until the seventh week that the C.C.S. fell appreciably below that of the initial test. Fibre determinations do show the influence of frost injury in that there is a steady rise as rotting becomes established after the third week of test.

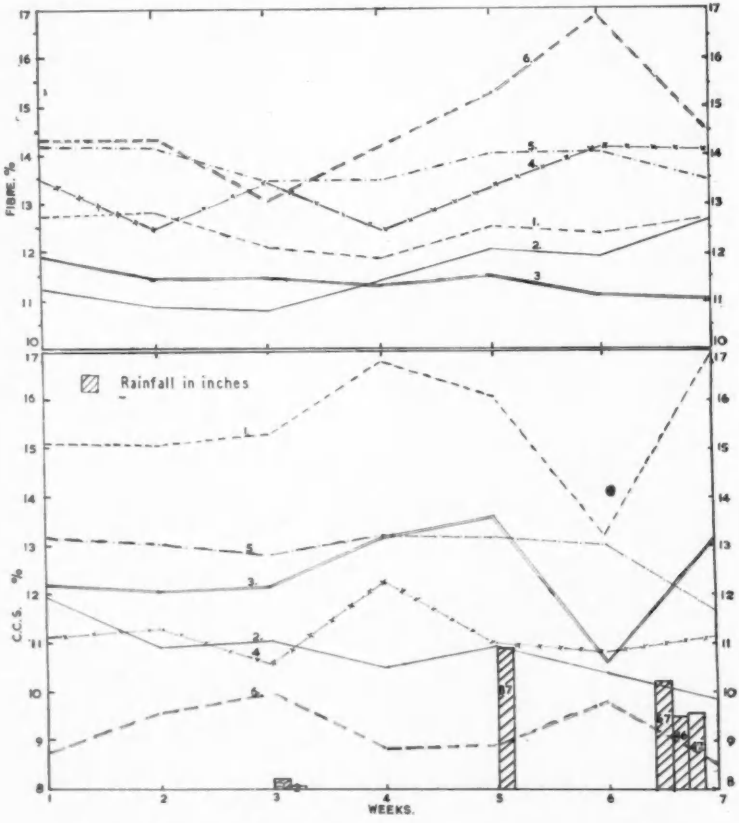
RATOONING OF FROSTED CANE

Because of the exceptionally wet conditions of the previous spring, crops were so very backward that Moreton mill completed its crushing in a period of 14 weeks instead of the normal 20 weeks. Many fields were so badly frosted and backward that harvesting was not considered practical or economical and the problem of continuing young stands of plants or first ratoon arose. The methods adopted followed in the main those outlined by Skinner [1] with a tendency to favour cultivation of the

interspace of a green (alive) crop followed by an application of a high nitrogen fertilizer mixture just before the summer growth period.

In the case of dead crops which had to be destroyed, the rolling of a field followed by tyne cultivation was not successful except in the case of a brittle variety which broke cleanly. With such canes as C.P.29/116 and Q.42 there was only slight breakage and the stalks assumed a fairly upright position after being rolled; in some cases the whole stool was uprooted and for these reasons the method was used very little and only with such canes as Q.28 or Trojan.

Apart from the cultivation and fertilizing of the green crop, rotary hoes proved useful in chopping down to stubble level the burnt remnants of small crops. However, this method has the disadvantage of incorporating in the soil large quantities of organic



No.1: Q.47- Growing point killed, eyes sound. No.4: C.P. 29/116- Growing points and eyes killed

No.2: Trojan-Growing point and eyes killed. No.5: Q.42 —— Growing points and eyes killed

No.3: Q.47- Growing point killed, eyes dead on upper half of stick. No.6: C.P. 29/116- Growing points and eyes killed

Fig. 17—The weekly changes in C.C.S. and fibre contents of damaged canes.

matter which may later cause nitrogen starvation. Even if pre-burning were carried out experience has indicated that the incorporation of crop residues causes a definite check to initial growth of ratoons sufficient to result in tonnage loss in the matured crop.

CONCLUSIONS

Observations were made on four commercial sugar cane varieties, two light coloured and two dark coloured and individual and group reactions to 1951 "killing" frosts were noted. Under the dry weather which prevailed the findings were:—

(a) There is a varietal resistance to apical bud and eye damage, the dark coloured varieties used in these observations being more resistant.

(b) Where conditions were equal, the dark canes also resisted rotting to a greater extent.

(c) There appeared to be a tendency on the part of the two green varieties to maintain the C.C.S. content.

(d) The influence of rain is to increase the fibre content of severely damaged cane and to depress the C.C.S. content of all varieties.

(e) To determine the extent of frost injury to an eye, the positive method of viewing a section longitudinally must be adopted.

(f) The favoured treatment of ratooning live stools of a frosted non-harvested young plant or first ratoon crop was the cultivation of the interspace with a later application of a high nitrogen mixture just prior to the summer months.

A Bulletin on Weedicides

HOW TO BUILD A BOOM SPRAY OUTFIT

The publication of Farm Bulletin No. 12 has been completed and copies are now available to canegrowers on request. This Bulletin deals with the use of 2,4-D for pre-emergence control of weeds and grasses, and gives details of the correct procedure to be adopted in weed control with the new chemical weedicides. It contains information on the control of bell vine and star of Bethlehem in cane fields. The use of diesel oil and creosote contact sprays is also described and recommendations made for their correct usage.

The publication is profusely illustrated with pictures of farm-built boom sprays and gives clear working diagrams to enable a farmer to build his own outfit. The information given regarding pumps, nozzles, booms, pressure requirements will be of considerable assistance to those who are interetsed in chemical weed control and are considering constructing a boom spray.

It is available, free, from any of our Sugar Experiment Stations or country officers whose addresses will be found inside the front cover of this Quarterly Bulletin. It can also be forwarded from the Bureau Head Office on request. —L.G.V.

Field Day at Meringa

At Meringa Sugar Experiment Station, on Friday, May 23rd, approximately 400 canegrowers, mill staff and other persons interested in the sugar industry attended the annual field day from 10 a.m. to 5 p.m. The visitors were welcomed on arrival by the Director of Sugar Experiment Stations (Mr. N. J. King) and were taken around the numerous experiment station fields by members of the staff who explained items of interest to them. They were enabled to see the practical results of the work carried out by the Bureau during the preceding year.

Meringa is the cane breeding centre of the Bureau and its fields contained many thousands of cane seedlings from which are selected each year what may prove the commercial canes of the north. In addition to the locally bred canes visitors saw the varieties introduced from such overseas countries as Hawaii, Java, Taiwan, United States, Argentine, the West Indies, South Africa, and Fiji.

Every phase of seedling raising was available for examination. Cross pollination of varieties was seen in the forest land near the cultivation, young seedlings were in the glasshouse and the mature seedlings (nearly 12 months old) in the field.

After the tour of the Station, which occupied the entire morning, the visitors were entertained at lunch and the first part of the afternoon was devoted to a series of addresses by members of the Bureau staff. Mr. R. H. Watson, M.L.A., Chairman of the Cairns Canegrowers' Executive, proposed a vote of thanks to the Bureau staff and he was supported by Mr. H. N. Whittaker, General Manager of the Mulgrave Mill.

A very comprehensive display of tractors and implements was arranged by machinery firms and attracted considerable attention from canegrowers.

THE DIRECTOR'S ADDRESS

There is little doubt that the Queensland sugar industry is experiencing a period of economic distress. This is so self-evident that explanatory comment would be superfluous and would, in fact, be inadvisable at a time when an enquiry is proceeding into the financial position of growers and millers. It may be considered that industry economics are outside the scope of Bureau activities, but a little consideration will show that applied research must taken cognisance of certain aspects of industry costs.

The Bureau has always been fully conscious of the fact that its work is closely related to the canegrowers objective of producing the maximum amount of sugar per acre at the lowest possible cost. In fact, most of the Bureau's work is directed towards this end. A very vigorous cane variety producing 60 or 70 tons per acre would have little value to the industry if its sugar content were below an economic level. An insecticide which would control the cane grub would not have had the success achieved by B.H.C. if it had cost say £10 per acre for each crop. Weed control by chemical means would have little appeal if it cost more than cultivation methods. At all times during agricultural and milling research the matter of costs is in the forefront of our minds and new methods, varieties and practices are planned or produced with a view to increasing farm returns.

However, the matter is rather more complicated than that. Gross farm returns are but a small part of the story. The farmers' gross income is

to a certain extent limited by his assigned area, by the capacity of his soil to produce and by the sugar content of his crop. With these limitations there is little he can do to appreciably increase his gross return from canegrowing. But there are many ways in which he can reduce costs and thereby increase his net income, and the latter is the important one in farming economy. Let us examine some of these methods of reducing costs.

The Bureau is of the firm opinion and has ample evidence to support that opinion, that many North Queensland growers are using too much fertilizer or alternatively the the incorrect fertilizer. This is one of the major expenses in canegrowing today and we are at a loss to understand why growers are prepared to expend such large sums when years of experience have shown that the same results are achieved with a much lower outlay. Similarly we are puzzled to know why a canegrower who goes to such lengths to ensure getting value for his money when he buys farm machinery is prepared to buy hundreds of pounds worth of fertilizer without obtaining advice as to what particular type his soil needs. All too often do we find on farms that a canegrower is unable to state what kind of fertilizer he used. I have little doubt that a lot of growers present today would not know the composition of the fertilizer mixtures they are using. The cost of planting or ratooning mixtures varies between £25 and £35 per ton. This is a considerable variation in price and if a grower using 20 tons of fertilizer really requires the cheaper one but is using the most expensive because of lack of knowledge of his soil's requirements then his financial loss amounts to £200.

It is not uncommon in North Queensland for growers to use half a ton of fertilizer per acre—we know plenty who do but we have yet to find the farm which requires anything approaching this amount if intelligently farmed. The Bureau has carried out on farmers' properties a great number of quantitative trials in which varying amounts of sulphate of ammonia, potash and superphosphate have been used and it is relatively easy to define the economic maximum amount of each ingredient required. Larger amounts of fertilizer, beyond the economic maximum, may produce larger crops but they reduce net profits. A recent trial of this type in Innisfail showed that over three crops an annual dressing of 420 lb. sulphate of ammonia, 210 lb. superphosphate and 150 lb. potash gave a net return of £88 per acre higher than the non-fertilized cane, but when an extra 150 lb. of potash was included the net return dropped by £37 per acre.

Sulphate of ammonia now costs £37/16/3 per ton in North Queensland and the usual top dressing is about 3½ cwt. per acre, costing £6/12/3. Green manure crops are a much more economical method of supplying nitrogen to the soil. A crop of cowpeas or velvet beans will supply more than sufficient nitrogen for the needs of the plant cane crop and in addition will give the soil a quantity of much needed organic matter as well as protecting it during the wet season. You have seen on the Station to-day a crop of velvet beans. These could have been ploughed in last month and the land planted with cane in May. Such a crop cost 15/- per acre for seed and will save us the cost of applying any sulphate of ammonia on the plant cane. There will be large quantities of seed of this variety available this year from the Isis Canegrowers' Executive.

At the last Annual Conference of the A.S.P.A. I raised the matter of molasses and its fertilizing value. On present day fertilizer costs f.o.r. Brisbane, molasses is worth £3/5/- a ton

for its fertilizer value alone. Accordingly any grower who can obtain from his mill a supply of molasses at less than £3/5/- a ton delivered on the farm should take advantage of it in preference to using fertilizer. But have your soil analysed first and we will advise on the most economic quantity per acre to use.

When we introduced Q.50 into North Queensland it was realised that it was too vigorous for use on the best soils of these districts and we advised growers to plant it only on the poorer and drier lands. The experience of the 1951-52 dry season has shown Q.50 up in a very favourable light because the dry conditions suited the variety. The result has been that growers are planting too much Q.50 on lands which are unsuited to it and should a good season develop in 1952-53 there will be a lot of Q.50 crops lying down and attracting high cutting rates. It is not too late to attempt to retrieve this position. If any farmers have planted Q.50 on good lands I suggest that they fertilize it very lightly in the plant crop. Do not apply sulphate of ammonia next spring unless the crop is not developing satisfactorily. This is another way of reducing farm costs and it is one well worthy of your attention.

Our work during the past six years on chemical weed control is also designed to reduce cost of sugar production. This work would not have been persisted with if it had been more costly than cultivation methods. Besides being cheaper it is more efficient, since spraying with pre-emergence weedicides controls all weed and grass growth in the cane row, and such control is not possible with implements. In addition, most spraying carried out to date suggests that resulting cane crops are somewhat better owing to the reduction in root damage caused by cultivator tynes. Chemical weed control has many points of recommendation; it costs less than cultivation and chipping, it prevents the germination of plants which rob the cane crop of fertilizer and moisture, it allows development of a better root system and it remains effective during the wet season when implement work would be impossible. The Bureau is waiting for delivery from the printer of a bulletin which it has prepared on chemical weed control and the construction of boom sprays. Every farmer is advised to obtain one of these bulletins and to apply the method on his own property.

I hope that this talk to-day will suggest to you a few avenues of cost reduction on your farms. Any thinking canegrower must have realised by now that hit and miss methods of fertilization must be replaced by a sounder system based on actual soil requirements, and that if cultivation costs can be cut by changing to weedicide spraying then that change must be made. There is available to you all a good advisory service—use it to the full.

[Other addresses delivered at Field Day will be reproduced in the October number of this publication].